Algebra 1
Mathematics
Item Specifications

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Introduction

In 2014 Missouri legislators passed House Bill 1490, mandating the development of the Missouri Learning Expectations. In April of 2016, these Missouri Learning Expectations were adopted by the State Board of Education. Groups of Missouri educators from across the state collaborated to create the documents necessary to support the implementation of these expectations.

One of the documents developed is the item specification document, which includes all Missouri grade level/course expectations arranged by domains/strands. It defines what could be measured on a variety of assessments. The document serves as the foundation of the assessment development process.

Although teachers may use this document to provide clarity to the expectations, these specifications are intended for summative, benchmark, and large-scale assessment purposes.

Components of the item specifications include:

Expectation Unwrapped breaks down a list of clearly delineated content and skills the students are expected to know and be able to do upon mastery of the Expectation.

Depth of Knowledge (DOK) Ceiling indicates the highest level of cognitive complexity that would typically be assessed on a large scale assessment. The DOK ceiling is not intended to limit the complexity one might reach in classroom instruction.

Item Format indicates the types of items used in large scale assessment. For each expectation, the item format specifies the type best suited for that particular expectation.

Text Types suggests a broad list of text types for both literary and informational expectations. This list is not intended to be all inclusive: other text types may be used in the classroom setting. The expectations were written in grade level bands; for this reason, the progression of the expectations relies upon increasing levels of quantitative and qualitative text complexities.

Content Limits/Assessment Boundaries are parameters that item writers should consider when developing a large scale assessment. For example, some expectations should not be assessed on a large scale assessment but are better suited for local assessment.

Sample stems are examples that address the specific elements of each expectation and address varying DOK levels. The sample stems provided in this document are in no way intended to limit the depth and breadth of possible item stems. The expectation should be assessed in a variety of ways.

High School Algebra 1

Frequently asked questions for Item Specification and Sample Stems

1. What is the purpose of the Item Specification document?
Historically, Item Specification documents are written for test item writers. In Missouri, this document was seen as a resource for not only item writers, but teachers as well. The unwrapped section should provide more detail on the meaning of the standard and the sample stems should provide example items that also help clarify the standard. In this update, the language used in the Expanded Expectations document was included to merge the two documents for easier access. In some standards a "Notes" section was added to provide additional information.

2. Why do some unwrapped sections have the same few sentences at the beginning?
For standards that have multiple parts and are listed as sub expectations, e.g., NF.C.5.b, the first part highlights the intent of that standard series. Often, these standards should be taught together as they develop a bigger idea or concept.

3. Why is the Fluency definition only on some standards?
Certainly, students having experience using different strategies and picking the strategy they feel best for given situations is important to improving student knowledge in mathematics. The Missouri Educators working on the document felt it important to highlight areas where student access to multiple strategies would provide the greatest support. Listing fluency in all standards would likely lessen the impact needed.

4. What does the "e.g." mean when listed in the unwrapped section?
The "e.g." is a way to highlight a list of examples, ideas, or concepts. It is **not** an exhaustive list, nor is it intended to represent the best examples. It is merely a partial list to provide some examples.

5. What does "with or without context" mean?
This phrase was used to highlight that the math problems might have some situational context or could possibly be a strictly number or symbol situation. The Educators working on this update wanted the focus to be on using math to solve problem situations rather than a focus on "real world" problems.

6. Are the Sample Stems examples of summative test items?
The Sample Stems could be a classroom item or possibly an assessment item. In some cases, the problem used would have to be adjusted to use on a Statewide assessment. The goal was to give students and teachers a problem that aligns to the standard. The Stems provided in the document are an example. The educators assisting with the update in some cases created more than one example and those are listed at the bottom of the document. All examples are good, some fit better on the page within the Item Specification which have determined those shown in both places.

7. Why are there no answers listed with the Sample Stems?
The focus of the Sample Stems should be on the work students can demonstrate to indicate their level of understanding for the given standard. While the answer is one component, when given, it frequently becomes the focus which does not provide important information in the learning process.

8. What does "No Limits" mean in the Limits and Boundaries section?
Where there are no limits or boundaries to be listed, "No Limits" was used to indicate this situation and help those using the document understand that it wasn't an oversight. IMPORTANT NOTE: if the standard itself or the cluster heading lists a specific limit, e.g., specific denominators, size or type of number, that was not duplicated in the Limits section.

9. Why do some words show a short definition?
While this does not serve as a replacement for a glossary, there were terms within the unwrapping that the committee felt should have meaning included. This occurs in the standard where it specifically addresses the concept in the standard, e.g., cardinality, trapezoid.

10. Why are Kindergarten and Grade 1 Sample Stems a bit different?
Students in Kindergarten and Grade 1 are beginning readers, so teachers should expect to read problems to the students rather than only providing problems to be solved.

Mathematics		A1.NQ.A.1
NQ A 1	**Number and Quantity** **Extend and use properties of rational exponents.** Explain how the meaning of rational exponents extends from the properties of integer exponents.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will explain how rational exponents extend from the properties of integer exponents, *e.g.*, $\left(5^{\frac{1}{3}}\right)^3 = 5$.

The student will know and apply the properties of rational exponents to generate equivalent algebraic expressions including expressions with more than one operation.

Sample Stems

What value could be used to make the equation below true? Explain your thinking.

$$(x)^{\frac{m}{n}} \cdot (\square) = x$$

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limit the numerator of rational exponents to 1.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics	A1.NQ.A.2

NQ.A.2

Number and Quantity

Extend and use properties of rational exponents.

Rewrite expressions involving radicals and rational exponents using the properties of exponents. Limit to rational exponents with a numerator of 1.

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will generate equivalent expressions involving simple radicals and rational exponents using the properties of exponents. Limit to rational exponents with a numerator of 1, *e.g.,* $\sqrt[n]{x} = x^{\frac{1}{n}}$. While simplification is not required, students should have the fluency to recognize equivalent forms of radical expressions.

Mathematical Fluency is more than a quick answer on some timed test. Students demonstrate Fluency when they do mathematics using an ***appropriate strategy*** in a reasonable amount of time, ***knowing multiple processes*** and can apply or adapt strategies to find a correct solution.

The student will rewrite expressions involving radicals and rational exponents to solve problems with or without context using the properties of exponents.

Sample Stems

Patti is looking at exponents and patterns. She begins with the table below looking at the far-left column and sees that each row is changing by multiplying by 2. She notices that the second column is showing the exponential representation when the base is 2.

1	2^0	4^0	8^0
2	2^1	$4^?$	$8^?$
4	2^2	4^1	$8^?$
8	2^3	$4^?$	8^1
16	2^4	4^2	$8^?$

What patterns do you see in the 3rd and 4th columns and what exponential values can you use to replace the "?" shown? Explain how the pattern can be represented in the table including the exponent values.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limit to rational exponents with a numerator of 1.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 1

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.NQ.B.3.a
NQ	**Number and Quantity**	
B	**Use units to solve problems.**	
3	Use units of measure as a way to understand and solve problems involving quantities.	
a	Identify, label and use appropriate units of measure within a problem.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.NQ.B.3 (a through d) indicate how Algebra 1 students will use units of measure as a way to understand and solve problems involving quantities such as rates, time, length, area, and capacity.

The student will identify, label, and use appropriate units of measure, e.g., squared units for area, cubic units for volume, in a problem with or without context.

Sample Stems

Tim got a new table to put in his room. The table was 4 feet by 3 feet and was 30-inches tall. If his room was a 10-foot by 10-foot room with 8 feet ceilings, how much of the floor space is covered by the new table. Show a labeled sketch of Tim's room and be sure to use the appropriate measurement labels in your work to explain your solutions.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.NQ.B.3.b
NQ	**Number and Quantity**	
B	**Use units to solve problems.**	
3	Use units of measure as a way to understand and solve problems involving quantities.	
b	Convert units and rates.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.NQ.B.3 (a through d) indicate how Algebra 1 students will use units of measure as a way to understand and solve problems involving quantities such as rates, time, length, area, and capacity.

The student will convert units and rates within and between systems of measure, e.g., inches per second to miles per hour, on problems with or without context.

Note:
Conversions should be embedded in the problem when converting between two systems, e.g., millimeters per yard given conversion from metric to standard.

Sample Stems

Which is larger? 2 square yards or 24 square feet? Explain or show your reasoning.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.NQ.B.3.c
NQ	**Number and Quantity**	
B	**Use units to solve problems.**	
3	Use units of measure as a way to understand and solve problems involving quantities.	
c	Use units within problems.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.NQ.B.3 (a through d) indicate how Algebra 1 students will use units of measure as a way to understand and solve problems involving quantities such as rates, time, length, area, and capacity.

The student will use units within multi-step problems with or without context.

Note:
Conversions should be embedded in the problem when converting between two systems, e.g., millimeters per yard given conversion from metric to standard.

Sample Stems

Tim got a new table to put in his room. The table was 4 feet by 3 feet and was 3 feet tall. If his room was a 10-foot by 10-foot room with 8 feet ceilings, how much of the floor space is covered and how much of the room space is taken up by the new table. Be sure to use the appropriate measurement labels in your work to explain your solutions.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 3

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.NQ.B.3.d
NQ	**Number and Quantity**	
B	**Use units to solve problems.**	
3	Use units of measure as a way to understand and solve problems involving quantities.	
d	Choose and interpret the scale and the origin in graphs and data displays.	

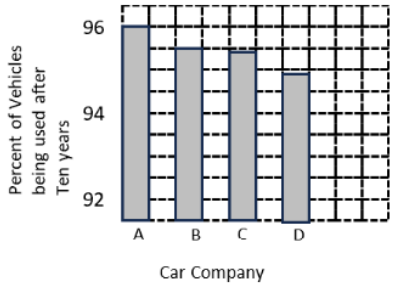
Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.NQ.B.3 (a through d) indicate how Algebra 1 students will use units of measure as a way to understand and solve problems involving quantities such as rates, time, length, area, and capacity.

The student will choose and interpret the scale for representations with or without context for horizontal and vertical axes and the origin in graphs and data displays. This includes information displayed in a misleading way.

Sample Stems

Company A claims that their cars are clearly better since so many more are still on the road after ten years. Interpret the scale, origin, and any other appropriate elements to determine if you agree or disagree with Company A. Be sure to use values in the graph to support your claim.



Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.NQ.B.4
NQ **B** **4**	**Number and Quantity** **Use units to solve problems.** Define and use appropriate quantities for representing a given context or problem.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.	**Sample Stems**
The student will determine, identify, and use appropriate quantities to represent (model) a given situation with or without context.	Jimmy has a gift box that he wants to wrap to give as a present. Describe what he will need to know to wrap the gift. Be sure to provide the appropriate quantities necessary for this given situation. Additional Stems for Algebra 1 Found at End of Document.
State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits No Limits.	**Calculator Designation** **YES** – a calculator will be available for items
DOK Ceiling: 2	
Item Format: Selected Response, Constructed Response, Technology Enhanced	

Mathematics		A1.NQ.B.5
NQ B 5	**Number and Quantity** **Use units to solve problems.** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	
Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations. The student will choose a level of accuracy appropriate to limitations on measurement when reporting quantities, e.g., problems involving money. Note: The student should be able to discuss how measurements can be impacted by the precision of any given tool.		**Sample Stems** Two friends are comparing their heights to that of their math teacher. Describe the type of tool they should use to make these comparisons. Be sure your description includes how accurate the tool is to this "competition". Additional Stems for Algebra 1 Found at End of Document.
State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits No Limits.		**Calculator Designation** **YES** – a calculator will be available for items
DOK Ceiling: 2		
Item Format: Selected Response, Constructed Response, Technology Enhanced		

Mathematics		A1.SSE.A.1
SSE A 1	**Seeing Structure in Expressions** **PRIORITY STANDARD** **Interpret and use structure.** Interpret the contextual meaning of individual terms or factors from a given problem that utilizes formulas or expressions.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.	**Sample Stems**
The student will utilize formulas or expressions to understand and interpret the contextual meaning of individual terms or factors from a given situation.	The class has been given an equation that models the growth of a plant in their classroom. The model being used is $y = 3x + 4$. They measure the number of inches the plant grows every 2 weeks. Given this situation, interpret the contextual meaning of each term in the model. Additional Stems for Algebra 1 Found at End of Document.
State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits Limit polynomials to degree three or lower.	**Calculator Designation** **YES** – a calculator will be available for items
DOK Ceiling: 2	
Item Format: Selected Response, Constructed Response, Technology Enhanced	

Mathematics		A1.SSE.A.2
SSE A 2	**Seeing Structure in Expressions** **Interpret and use structure.** Analyze the structure of polynomials to create equivalent expressions or equations.	**PRIORITY STANDARD**

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will analyze the structure of polynomial expressions or equations in order to be rewritten in equivalent forms. Analyzing a polynomial structure involves students having the flexibility to consider which form provides the information to support the context of the situation. Students will use this fluency to purposefully transform the expression or equation into equivalent forms.

Note:
For Algebra 1 classroom experiences, students should experience polynomials in different forms and have the opportunity to create equivalent expressions or equations.

Mathematical Fluency is more than a quick answer on a timed test. Students demonstrate Fluency when they do mathematics using an ***appropriate strategy*** in a reasonable amount of time, ***knowing multiple processes*** and can apply or adapt strategies to find a correct solution.

The student will analyze the structure of polynomials to solve problems with or without context to create equivalent expressions or equations.

Sample Stems

Given the equation listed below, what are other equivalent forms for this equation? What are the benefits for each equivalent form?

$$y + 24 = x^2 + 2x$$

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limited to integer coefficients for polynomials with a degree greater than one.
Limited to polynomials of nth degree with a GCF that, when factored, results in a factorable quadratic expression.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.SSE.A.3.a
SSE	**Seeing Structure in Expressions**	
A	**Interpret and use structure.**	
3	Choose and produce equivalent forms of a quadratic expression or equations to reveal and explain properties.	
a	Find the zeros of a quadratic function by rewriting it in factored form.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.SSE.A.3 (a and b) indicate how Algebra 1 students will choose and produce equivalent forms of a quadratic expression to reveal and explain properties of the quantity represented by the expression.

The student will use the factors of a quadratic function to find the intercepts (zeros) of the function.

Sample Stems

Given the function listed below, find the zeros by showing the function rewritten in factored form.

$$f(x) = x^2 + 7x - 8$$

What are the zeros in a function?

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limited to integer coefficients and given $f(x) = ax^2 + bx + c$, and $|a \cdot c| \leq 100$.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.SSE.A.3.b
SSE	**Seeing Structure in Expressions**	
A	**Interpret and use structure.**	
3	Choose and produce equivalent forms of a quadratic expression or equations to reveal and explain properties.	
b	Find the maximum or minimum value of a quadratic function by completing the square.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.SSE.A.3 (a and b) indicate how Algebra 1 students will choose and produce equivalent forms of a quadratic expression to reveal and explain properties of the quantity represented by the expression.

The student will find the maximum or minimum value, located at (h, k), of a quadratic function by completing the square resulting in the vertex form of a quadratic function, $y = a(x - h)^2 + k$.

Sample Stems

Given the function listed below, find the maximum or minimum value of the quadratic function by completing the square.

$$f(x) = x^2 + 7x - 8$$

Be sure to show your work and identify how you know whether the coordinate is a maximum or minimum.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limit values of a to one or be the greatest common factor of the terms of the function, given $f(x) = ax^2 + bx + c$.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.CED.A.1
CED A 1	**Creating Equations** **Create equations that describe linear, quadratic and exponential relationships.** Create equations and inequalities in one variable and use them to model and/or solve problems.	**PRIORITY STANDARD**

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will create equations and inequalities in one variable and use them to model and/or solve problems with or without context. Algebra 1 includes linear, quadratic, and exponential equations as well as linear and exponential inequalities.

Note:
In Algebra 1 with inequalities, the focus should be on linear or quadratic relationships and, as with all equations or inequalities, tables or graphing utilities are an appropriate strategy to utilize.

Sample Stems

Tina and Tim are planning to sell ice cream bars at a fair in their town. They plan to sell each bar for $2 and they must pay $25 for space for their booth. If they hope to make at least $200, how many bars must they sell?

Create an equation or inequality to model and solve this situation.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 3

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.CED.A.2
CED A 2	**Creating Equations** **Create equations that describe linear, quadratic and exponential relationships.** Create and graph linear, quadratic and exponential equations in two variables.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will create and graph linear, quadratic, and exponential ($y = ab^x$ or $y = ab^x + c$) equations in two variables with or without context.

Sample Stems

Surf City, Missouri has been growing in population. This year their population is currently 5,200. If Surf City grows annually at a rate of 10 percent, what would be their predicted population in 15 years? Create a model to represent this situation and find the solution.

Additional Stems for Algebra 1 Found at End of Document

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limit exponentials to the forms $y = ab^x$ or $y = ab^x + c$, where b > 0 and not equal to 1.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 3

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.CED.A.3
CED A 3	**Creating Equations** **Create equations that describe linear, quadratic and exponential relationships.** Represent constraints by equations or inequalities and by systems of equations or inequalities, and interpret the data points as a solution or non-solution in a modeling context.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will represent constraints based upon a given context or situation using equations or inequalities, including systems of equations or inequalities.

The student will interpret data points as a solution or non-solution based on the context or situation being modeled.

Sample Stems

Jimmy's sister is starting a lemonade business. Her expenses can be modeled by the following inequality $y \geq \frac{1}{5}x + 18$ and her earnings are modeled by $y \geq 2x$. Identify the constraints generated by these models and identify data points that would be solutions as well as data points that would not be a solution.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limit the representations of the constraints to linear equations or linear inequalities.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 3

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.CED.A.4
CED **A** **4**	**Creating Equations** **Create equations that describe linear, quadratic and exponential relationships.** Solve literal equations and formulas for a specified variable that highlights a quantity of interest.	
Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations. The student will solve literal equations and formulas for a specified variable that highlights a particular value, e.g., solving the distance formula (distance equals rate times time) d=rt for r.		**Sample Stems** Solve the distance formula for r and create a situation where knowing r's value would be of interest. Additional Stems for Algebra 1 Found at End of Document.
State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits Limited to formulas and equations with degree three or less.		**Calculator Designation** **YES** – a calculator will be available for items
DOK Ceiling: 2		
Item Format: Selected Response, Constructed Response, Technology Enhanced		

Mathematics		A1.REI.A.1
REI A 1	**Reasoning with Equations and Inequalities** **Understand solving equations as a process, and solve equations and inequalities in one variable.** Explain how each step taken when solving an equation or inequality in one variable creates an equivalent equation or inequality that has the same solution(s) as the original.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will explain the process of solving equations and inequalities including how each step is equivalent and the solution(s) remains the same.

Note:
The focus should be on justifying how the representations are equivalent using words, models, or properties.

Sample Stems

Given the inequality shown below, show each step needed to solve the problem and indicate how the inequality listed in each step is equivalent to the original problem using words, models, or properties.

$$7 - 3x > 18$$

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limited to linear equations and inequalities.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 3

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.REI.A.2.a
REI	**Reasoning with Equations and Inequalities**	
A	**Understand solving equations as a process, and solve equations and inequalities in one variable.**	
2	Solve problems involving quadratic equations.	
a	Use the method of completing the square to create an equivalent quadratic equation.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.REI.A.2 (a through c) indicate how Algebra 1 students will solve problems with or without context involving quadratic equations in one variable.

The student will use the method of completing the square to transform a quadratic equation into an equation that has the same solution. Students could demonstrate completing the square by using a model, e.g. manipulatives, or using algebraic steps.

Sample Stems

Given the equation listed below, use completing the square to create an equivalent equation.

$$y = x^2 - 7x - 8$$

Show your completing the square using a model or algebraic steps to defend your solution.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Given $y = ax^2 + bx + c$, If a > 1, a is the greatest common factor of the terms of the quadratic function.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.REI.A.2.b
REI	**Reasoning with Equations and Inequalities**	
A	**Understand solving equations as a process, and solve equations and inequalities in one variable.**	
2	Solve problems involving quadratic equations.	
b	Derive the quadratic formula.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.REI.A.2 (a through c) indicate how Algebra 1 students will solve problems with or without context involving quadratic equations in one variable.

The student will derive the quadratic formula from $ax^2 + bx + c = 0$, with a, b, and c being real numbers. Students will show their thinking using words, symbolic representations, or models, e.g., algebra tiles, graphing utility.

Sample Stems

Derive the quadratic formula from the following, $ax^2 + bx + c = 0$, with a, b, and c being real numbers. Show you thinking using words, symbolic representations, or models.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 3

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.REI.A.2.c
REI	**Reasoning with Equations and Inequalities**	**PRIORITY STANDARD**
A	**Understand solving equations as a process, and solve equations and inequalities in one variable.**	
2	Solve problems involving quadratic equations.	
c	Analyze different methods of solving quadratic equations.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.REI.A.2 (a through c) indicate how Algebra 1 students will solve problems with or without context involving quadratic equations in one variable.

The student will analyze different methods of solving quadratic equations, e.g., by inspection, using the square root property, completing the square, using the quadratic formula, graphing, and factoring. For this expectation, to analyze involves identifying and explaining the method the student sees as most effective to solve quadratic equations.

Note:
For Algebra 1, students should experience quadratics with complex solutions and realize that there are no real solutions in those situations.

Mathematical Fluency is more than a quick answer on a timed test. Students demonstrate Fluency when they do mathematics using an ***appropriate strategy*** in a reasonable amount of time, ***knowing multiple processes*** and can apply or adapt strategies to find a correct solution.

The student will analyze different methods to solve problems with or without context to determine the solution of quadratic equations.

Sample Stems

Of the four methods (graphing, factoring, completing the square, quadratic formula) list a pro (or an ideal situation) and a con (a less ideal situation) to using each method.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 3

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.REI.B.3
REI B 3	**Reasoning with Equations and Inequalities** **Solve systems of equations.** Solve a system of linear equations algebraically and/or graphically.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will solve a system of linear equations with or without context.

Mathematical Fluency is more than a quick answer on a timed test. Students demonstrate Fluency when they do mathematics using an ***appropriate strategy*** in a reasonable amount of time, ***knowing multiple processes*** and can apply or adapt strategies to find a correct solution.

The student will use and explain multiple strategies to solve problems with or without context to determine the solution of systems of linear equations.

Sample Stems

Given the following system, what would the values of Q and P need to be for each of these situations: An infinite number of solutions, one solution, and no solutions. Explain your choices.

$y = 3x + 8$ and $y = Qx + P$

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limited to two equations per system.
Limit solutions to intersecting grid lines when solving systems by graphing when only given a graph.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.REI.B.4
REI B 4	**Reasoning with Equations and Inequalities** **Solve systems of equations.** Solve a system consisting of a linear equation and a quadratic equation algebraically and/or graphically.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will solve a system consisting of a linear equation and a quadratic equation with or without context.

Note:
For Algebra 1, students should experience systems of linear equations (extending the work from 8th grade) and quadratic equations with various solution situations (zero, one or two solutions).

Mathematical Fluency is more than a quick answer on a timed test. Students demonstrate Fluency when they do mathematics using an ***appropriate strategy*** in a reasonable amount of time, ***knowing multiple processes*** and can apply or adapt strategies to find a correct solution.

The student will use and explain multiple strategies to solve problems with or without context to determine the solution of a system of linear and quadratic equations.

Sample Stems

Algebraically or graphically, solve the system shown below.

$$y = x^2 - 2x - 3$$

$$4x + 2y = 12$$

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limit solutions to intersecting grid lines when solving systems by graphing when only given a graph.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.REI.B.5
REI B 5	**Reasoning with Equations and Inequalities** **Solve systems of equations.** Justify that the technique of linear combination produces an equivalent system of equations.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will justify that given a system of two equations in two variables, the solution is not changed when one or both equations is/are replaced by a linear combination of itself, e.g., multiply each term of an equation by 3.

Sample Stems

Ginny claims that the following two systems are equivalent. Justify how they could both represent the same system.

$$\begin{aligned} 2x + y &= 8 \\ -4x + y &= 4 \end{aligned} \qquad \begin{aligned} 4x + 2y &= 16 \\ -4x + y &= 4 \end{aligned}$$

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.REI.C.6
REI C 6	**Reasoning with Equations and Inequalities** **PRIORITY STANDARD** **Represent and solve linear and exponential equations and inequalities graphically** Explain that the graph of an equation in two variables is the set of all its solutions plotted in the Cartesian coordinate plane.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will explain that the graph of an equation in two variables is the set of all its solutions plotted in the Cartesian coordinate plane.

Note:
For this cluster, the focus is on linear and exponential equations.

Sample Stems

Graph the following equation and explain the connection between the equation and its graph.

$y = 2^x + 3$

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limit exponentials to the form $y = ab^x + c$, where b > 0 and not equal to 1.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.REI.C.7
REI C 7	**Reasoning with Equations and Inequalities** **Represent and solve linear and exponential equations and inequalities graphically** Graph the solution to a linear inequality in two variables.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.	**Sample Stems**
The student will graph the solutions to a linear inequality in two variables.	Graph and describe the solution(s) to the following inequality. $2x - 5y < 15$ Additional Stems for Algebra 1 Found at End of Document.
State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits No Limits.	**Calculator Designation** **YES** – a calculator will be available for items
DOK Ceiling: 2	
Item Format: Selected Response, Constructed Response, Technology Enhanced	

Mathematics		A1.REI.C.8
REI C 8	**Reasoning with Equations and Inequalities** **Represent and solve linear and exponential equations and inequalities graphically** Solve problems involving a system of linear inequalities.	**PRIORITY STANDARD**

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will solve problems with or without context for a system of linear inequalities by graphing, and when appropriate, interpreting the solutions given the context provided.

Mathematical Fluency is more than a quick answer on a timed test. Students demonstrate Fluency when they do mathematics using an ***appropriate strategy*** in a reasonable amount of time, ***knowing multiple processes*** and can apply or adapt strategies to find a correct solution.

The student will use and explain multiple strategies to solve problems with or without context to determine the solution of a system of linear inequalities.

Sample Stems

Jimmy's sister is starting a lemonade business. Her expenses can be modeled by the inequality $y \geq \frac{1}{5}x + 18$ and her earnings are modeled by $y \geq 2x$. Identify any solution(s) to this system and interpret their meaning given this context.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limited to systems of two linear inequalities.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.APR.A.1
APR A 1	**Arithmetic with Polynomials and Rational Expressions** **Perform operations on polynomials.** Add, subtract and multiply polynomials, and understand that polynomials follow the same general rules of arithmetic and are closed under these operations.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will add, subtract, and multiply polynomials, and understand that polynomials follow the same general rules as arithmetic and are closed (the sum, difference and product of polynomials will result in a polynomial) under these operations.

Sample Stems

Which operation, + - or x, would create the largest solution for the following expression.

$x^2 - 2x - 15 \bigcirc x^2 - 3x - 70$

Explain your answer using mathematical work and reasoning.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limit multiplication problems to a binomial times a trinomial, at most.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.APR.A.2
APR A 2	**Arithmetic with Polynomials and Rational Expressions** **Perform operations on polynomials.** Divide polynomials by monomials.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will divide polynomials by monomials.

Sample Stems

Simplify the following and collect like terms:

$$\frac{2x^2 - 3x}{x}$$

$$\frac{16x^2 - 4}{2}$$

$$\frac{20x^2 + 5x}{5x}$$

$$\frac{3x^2 + 5x}{x^2}$$

Use these expressions to explain why the operations of addition and multiplication are closed for polynomials. Why is division not closed?

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.IF.A.1.a
IF	**Interpreting Functions**	
A	**Understand the concept of a function and use function notation.**	
1	Understand that a function from one set (domain) to another set (range) assigns to each element of the domain exactly one element of the range.	
a	Represent a function using function notation.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.IF.A.1 (a and b) show how Algebra 1 students will develop an understanding that a function from one set (domain) to another set (range) assigns to each element of the domain exactly one element of the range.

The student will extend previous knowledge of a function to apply to general behavior and features of a function using function notation, e.g., $f(x), g(x)$. The student will understand that each element of the domain of a function corresponds to exactly one element in the range.

Sample Stems

The table below shows four terms in a function.

Domain	1	2	3	4
Range	2	4	6	8

Write this function in function notation.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limited to linear, quadratic, and exponential relationships.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.IF.A.1.b
IF	**Interpreting Functions**	
A	**Understand the concept of a function and use function notation.**	
1	Understand that a function from one set (domain) to another set (range) assigns to each element of the domain exactly one element of the range.	
b	Understand that the graph of a function labeled f is the set of all ordered pairs (x, y) that satisfy the equation $y=f(x)$.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.IF.A.1 (a and b) show how Algebra 1 students will understand that a function from one set (domain) to another set (range) assigns to each element of the domain exactly one element of the range.

The student will understand that the graph of a function labeled *f* is the set of all ordered pairs *(x,y)* that satisfies (represents) the equation $y = f(x)$, where *x* represents the inputs (domain) and *y* represents the outputs (range).

The student will understand that all of the ordered pairs on the graph of a function labeled *f* are solutions to $f(x)$ such that $y = f(x)$.

Note:
Functions can be named with letters other than f, *e.g.,* $g(x)$, $h(x)$.

Sample Stems

How can you use the graph of the following equation to verify that it is indeed a function?

$$f(x) = 7x + 2$$

Support your explanation including how domain, range, and ordered pairs that satisfy the equation.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.IF.A.2
IF A 2	**Interpreting Functions** **Understand the concept of a function and use function notation.** Use function notation to evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will use function notation to evaluate functions for inputs in their domains and interpret statements that use function notation in terms of a context.

Note:
Functions can be named with letters other than f, *e.g.,* $g(x)$, $h(x)$.

Sample Stems

A function $C(m)$ gives the number of canceled school days, C, for any given month, m. What does $C(1) = 6$ mean in the context of this situation?

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limited to linear, exponential, and quadratic functions.
Limit solutions to intersecting grid lines when only given a graph.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.IF.B.3
IF **B** **3**	**Interpreting Functions** **PRIORITY STANDARD** **Interpret linear, quadratic and exponential functions in terms of the context.** Using tables, graphs and verbal descriptions, interpret key characteristics of a function that models the relationship between two quantities.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will use tables, graphs, and verbal descriptions to interpret the key characteristics of a function that models the relationship between two quantities. Key characteristics include slope (rate of change), x and y intercepts; intervals where the function is increasing, decreasing or constant; intervals where the function output is positive, negative or zero; relative maximum or minimum; symmetries; and end behavior.

Note:
Intercepts should be written as ordered pairs or verbal descriptions, e.g. the x intercept is 6. Notation for domain and range should be written in inequality notation, e.g., $x > 0$, or as a verbal description, e.g., all real numbers, positive real numbers.

Sample Stems

Audrey and Aaron have summer jobs stuffing envelopes for two different companies. Audrey earns $12 for every 400 envelopes she finishes. Aaron earns $6 for every 300 envelopes he finishes.

Describe the key characteristics for each function that would model these two relationships. How would these characteristics help to compare each person's earnings after stuffing the same number of envelopes?

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 3

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.IF.B.4
IF **B** **4**	**Interpreting Functions** **Interpret linear, quadratic and exponential functions in terms of the context.** Relate the domain and range of a function to its graph and, where applicable, to the quantitative relationship it describes.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will relate the domain and range of a function to its graph and, where applicable, to the quantitative relationship it describes, including situations in context.

Note:
Notation for domain and range should be written in inequality notation, e.g., $x > 0$, or as a verbal description, e.g., all real numbers, positive real numbers.

Sample Stems

Baxter deposits $500 into a savings account that earns 2% interest each year. The function below represents how much money *A* is in Baxter's account *t* years after the savings account is opened.

$$A = 500(1.02)^t$$

Graph this function and use the graph to describe the domain and range of the function and how the graph supports your description.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.IF.B.5
IF **B** **5**	**Interpreting Functions** **Interpret linear, quadratic and exponential functions in terms of the context.** Determine the average rate of change of a function over a specified interval and interpret the meaning.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will determine the average rate of change of a function over a specified interval when given a graph, equation or table.

The student will interpret the meaning of the average rate of change over a specified interval based on the situation.

Sample Stems

The table shows a company's value over several years after being founded:

Time in years	1	2	3	4	5
Value (in thousands of dollars)	10	15	17	8	-20

Describe the company's performance between years 1 and 5, including the average rate of change and a description of what that means in this context.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.IF.B.6
IF **B** **6**	**Interpreting Functions** **Interpret linear, quadratic and exponential functions in terms of the context.** Interpret the parameters of a linear or exponential function in terms of the context.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will interpret the parameters of a linear or exponential function in terms of the context, e.g., explain what happens to the values of the functions' parameters as the value of t changes for the situation described by the equation representing function $A=300(0.96)^t$.

For this expectation, parameters for linear functions include slope, intercepts, point on the line; and exponential functions ($y = ab^x$) include *a* as the initial value and *b* as the growth or decay factor. The parameters influence the domain, range, and number of intervals.

Sample Stems

Using the function $A = 300(0.96)^t$, identify a situation or context the function represents. Explain what happens to the value of the function as the values for *t* increase. Be sure to indicate the meaning of the relevant parts of the function.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

High School Algebra 1

Mathematics		A1.IF.C.7
IF **C** **7**	**Interpreting Functions** **Analyze linear, quadratic and exponential functions using different representations.** Graph functions expressed symbolically and identify and interpret key features of the graph.	**PRIORITY STANDARD**

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will graph linear, quadratic, exponential and piecewise-defined functions, from their symbolic representation both by hand and by using technology.

The student will analyze key features of the graph.

For this expectation, key features include slope; x and y intercepts; intervals where the function is increasing, decreasing or constant; intervals where the function output is positive, negative or zero; relative maximum or minimum; symmetries; and end behavior.

Mathematical Fluency is more than a quick answer on some timed test. Students demonstrate Fluency when they do mathematics using an ***appropriate strategy*** in a reasonable amount of time, ***knowing multiple processes*** and can apply or adapt strategies to find a correct solution.

The student will graph functions expressed symbolically to solve problems with or without context to identify and interpret key features of the graph.

Sample Stems

Sutton used her graphing utility to compare each of the graphs below to the graph of using several values for *a, h*, and *k*. She noticed some patterns in the changing of the graph. What patterns might have Sutton seen? Be sure to include in your discussion how the graph changes including shifts and the direction of the shift, as well as stretches. Be specific to the effect *a, h*, and *k*. have on the graph and include some of the values you used in your exploration.

$$y = ax^2$$
$$y = (x + h)^2$$
$$y = x^2 + k$$

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Piecewise functions limited to linear only.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.IF.C.8
IF C 8	**Interpreting Functions** **Analyze linear, quadratic and exponential functions using different representations.** Translate between different but equivalent forms of a function to reveal and explain properties of the function and interpret these in terms of a context.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will describe the differences between equivalent forms to reveal key features of a function. The purpose of translating between equivalent forms is to fluently reveal and explain different properties of the function and interpret these in terms of a context.

For this expectation, key features include slope; x and y intercepts; intervals where the function is increasing, decreasing or constant; intervals where the function output is positive, negative or zero; relative maximum or minimum; symmetries; and end behavior.

Mathematical Fluency is more than a quick answer on some timed test. Students demonstrate Fluency when they do mathematics using an ***appropriate strategy*** in a reasonable amount of time, ***knowing multiple processes*** and can apply or adapt strategies to find a correct solution.

The student will translate between different but equivalent forms of a function to solve problems with or without context to reveal and explain properties of the function and interpret these in terms of a context.

Sample Stems

Thomas and Shawna are graphing the quadratic function $y = 2x^2 - 4x - 6$

Thomas claims the function is easier to graph in the form $y = 2(x - 3)(x + 1)$

Shawna disagrees and claims that she would rather graph it in the form $y = 2(x - 1)^2 - 8$

For each student explain how their form might be easier to graph. Be sure to include a description of the key features to defend each position.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limit to linear and quadratic functions.

Calculator Designation

YES – a calculator will be available for item

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.IF.C.9
IF C 9	**Interpreting Functions** **Analyze linear, quadratic and exponential functions using different representations.** Compare the properties of two functions given different representations.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will compare the properties (key features) of two functions given different representations, e.g., tables, graphs, equations, or verbal descriptions.

For this expectation the key features include slope; x and y intercepts; intervals where the function is increasing, decreasing or constant; intervals where the function output is positive, negative or zero; relative maximum or minimum; symmetries; and end behavior.

Sample Stems

At a high school baseball game, a throwing contest is held. The path of Sam's throw is given by the equation $y = -16t^2 + 70t + 7$

Where y represents the height of the ball t seconds after it is thrown.

Jessica's throw is given in the table below:

Time after throwing in seconds	0	.5	1	1.5
Height of ball above ground in feet	5.5	37.5	61.5	77.5

Who would win the contest if the goal was to be highest, longest, or farthest? What key characteristics of the functions help determine the winner for each of these situations?

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limit exponentials to the form $y = ab^x$, where b is rational, greater than zero and not equal to 1.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 3

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.BF.A.1
BF **A** **1**	**Building Functions** **Build new functions from existing functions (limited to linear, quadratic and exponential).** Analyze the effect of translations and scale changes on functions.	**PRIORITY STANDARD**

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will analyze the effect of translations and scale changes on functions, which are both transformations on functions.

The student will describe the effect of the transformations on the graph of *f(x),* e.g. *kf(x), f(x)+k, f(x+k*), *af(x+k*) for specific values for the parameters *a* and *k*.

The student will find the specific value of *k* given the graphs of *f(x*) and the graph after transformations have been performed.

Sample Stems

Graph and use the following function to describe the effects of each of the transformations listed below.

$$f(x) = x^2 - 4$$

Transformations to use in your description:

$3f(x)$ $\quad f(x) + 4$

$f(x + 4)$ $\quad 3f(x + 4)$

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

High School Algebra 1

Mathematics		A1.LQE.A.1.a
LQE	Linear, Quadratic and Exponential Models	
A	**Construct and compare linear, quadratic and exponential models and solve problems.**	
1	Distinguish between situations that can be modeled with linear or exponential functions.	
a	Determine that linear functions change by equal differences over equal intervals.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.LQE.A.1 (a and b) indicate that Algebra 1 students will distinguish between situations that can be modeled with linear or exponential functions.

The student will show that linear functions change by equal differences over equal intervals.

Sample Stems

The population of Jefferson City, MO in 2021 was 42,772. What could the population have been in 2022, 2023, and 2024 if the population grew at a linear rate?

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.LQE.A.1.b
LQE	**Linear, Quadratic and Exponential Models**	
A	**Construct and compare linear, quadratic and exponential models and solve problems.**	
1	Distinguish between situations that can be modeled with linear or exponential functions.	
b	Recognize exponential situations in which a quantity grows or decays by a constant percent rate per unit interval.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.LQE.A.1 (a and b) indicate that Algebra 1 students will distinguish between situations that can be modeled with linear or exponential functions.

The student will show that exponential functions change by equal factors over equal intervals, e.g., by algebraic proof, with a table showing differences or by calculating average rates of change over equal intervals.

The student will recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

Sample Stems

Freddie the farmer's barn was being overrun with mice. He went out and got a cat that was very good at catching mice. On the day Freddie brought the cat home, he estimated that his barn had 1000 mice.

Use the information from the table below to describe the type of function represented by bringing the cat to the barn. Include specific information on how the estimated mouse population is changing to support your description.

Weeks after getting a barn cat	1	2	3
Estimated number of Mice in the barn	900	810	729

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limited to exponentials where $y = ab^x$, and b is rational, greater than zero and not equal to 1.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics	A1.LQE.A.2
LQE A 2	**Linear, Quadratic and Exponential Models** **Construct and compare linear, quadratic and exponential models and solve problems.** Describe, using graphs and tables, that a quantity increasing exponentially eventually exceeds a quantity increasing linearly or quadratically.

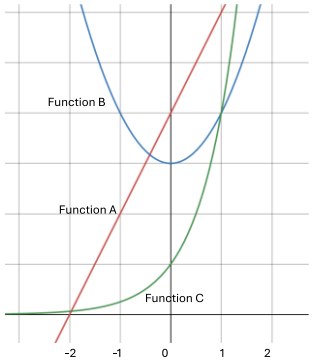
Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will describe, using graphs and tables, a quantity increasing exponentially eventually exceeds a quantity increasing linearly or quadratically.

Sample Stems

A group of students are comparing three different functions (Function A, Function B, and Function C).

Alina looks at the following graph of the three functions and determines that, because function A shows the greatest value after an input of approximately -0.5, function C will never be greater than function A. Do you agree or disagree? Why?



Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.LQE.A.3
LQE A 3	**Linear, Quadratic and Exponential Models** **Construct and compare linear, quadratic and exponential models and solve problems.** Construct linear, quadratic and exponential equations given graphs, verbal descriptions or tables.	**PRIORITY STANDARD**

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will construct linear, quadratic, and exponential equations given graphs, verbal descriptions, or tables.

For Algebra 1, constructing will involve creating and writing the equations to solve problems with or without context.

Sample Stems

Penicillin, a medication that eliminates bacteria, is introduced to a culture of 20,000 bacteria. The penicillin eliminates 65% of the bacteria each hour. Write a function to model the number of bacteria remaining each hour after the penicillin is administered.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Limited to exponentials where $y = ab^x$, and b is rational, greater than zero and not equal to one.
When writing the equation from a graph, all necessary information should be identifiable on intersecting grid lines.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.LQE.B.4
LQE B 4	**Linear, Quadratic and Exponential Models** **PRIORITY STANDARD** **Use arithmetic and geometric sequences.** Write arithmetic and geometric sequences in recursive and explicit forms, and use them to model situations and translate between the two forms.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will write arithmetic and geometric sequences in recursive and explicit forms, use them to model situations and translate between the two forms.

The student will connect arithmetic sequences to linear functions and geometric sequences to exponential functions.
Arithmetic Explicit $a_n = a_1 + (n\text{-}1)d$
Arithmetic Recursive $a_1 = 1^{st}$ term, $a_n = a_{n-1} + d$
Geometric Explicit $g_n = g_1 r^{n-1}$
Geometric Recursive $g_1 = 1^{st}$ term, $g_n = rg_{n-1}$

The student will construct (create and write) arithmetic and geometric sequences, given graphs, verbal descriptions, or tables.

Sample Stems

A popular game show gives its winner a choice of two prizes:

The first option is that the winner can receive $1000 tomorrow, and then receive $500 per day for a month.

The second option is that the winner can receive $2 tomorrow, $4 the day after, and continue to double the prize money each day for a month.

Which prize option should the winner select? Write a sequence that models each prize choice and use these to support your conclusion.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits
Recursive form should be limited to subscript notation.

Calculator Designation
YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.LQE.B.5
LQE B 5	**Linear, Quadratic and Exponential Models** **Use arithmetic and geometric sequences.** Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the set of integers.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will recognize that sequences are functions whose domain is a subset of the set of integers and are sometimes defined recursively.

Sample Stems

Compare (describe both the similarities and differences) the following sequences:

$f(n) = 2n + 1$

$a_{n+1} = a_{n-1} + a_n$, where $a_1 = 1$ and $a_2 = 3$

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Recursive form should be limited to subscript notation.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.LQE.B.6
LQE B 6	**Linear, Quadratic and Exponential Models** **Use arithmetic and geometric sequences.** Find the terms of sequences given an explicit or recursive formula.	
Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations. The student will find the terms of general sequences given either an explicit formula or a recursive formula.		**Sample Stems** Write the first 6 terms of the sequence: $a_{n+1} = a_{n-1} + a_n$ where $a_1 = 1$ and $a_2 = 3$ Additional Stems for Algebra 1 Found at End of Document.
State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits Recursive form should be limited to subscript notation.		**Calculator Designation** **YES** – a calculator will be available for items
DOK Ceiling: 1		
Item Format: Selected Response, Constructed Response, Technology Enhanced		

Mathematics		A1.DS.A.1
DS A 1	**Data and Statistical Analysis** **Summarize, represent and interpret data.** Analyze and interpret graphical displays of data.	**PRIORITY STANDARD**

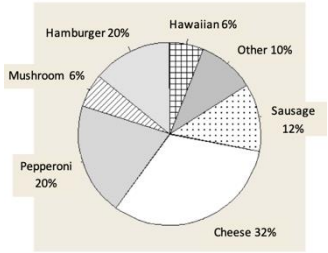
Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will analyze and interpret graphical displays of data (e.g., circle graphs, scatter plots, dot plots, histograms, box plots, and others).

For Algebra 1, any data display, univariate (one variable) or bivariate (two variable) data in the Data and Statistics Domain could be graphical displays to analyze and interpret.

Sample Stems

The pie chart below describes the distribution of favorite pizzas for 300 high school freshmen. Analyze the claims below to determine their accuracy in describing information contained in this chart.



- Taken together, more than half the students preferred pepperoni, hamburger, or sausage.
- Fewer than 10 students prefer mushroom pizza.
- Twelve students prefer either mushroom or Hawaiian pizza.
- No students like veggie pizzas.

More than 50 students prefer cheese pizza.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

High School Algebra 1

Mathematics		A1.DS.A.2
DS A 2	**Data and Statistical Analysis** **Summarize, represent and interpret data.** Use statistics appropriate to the shape of the data distribution to compare center and spread of two or more different data sets.	
Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations. The student will use statistics appropriate to the shape of the data distribution to compare the center, e.g., median, mean, mode; and spread, e.g., interquartile range and standard deviation, of two or more different data sets.		**Sample Stems** Based on the dot plots and summary statistics given below, which measures of center and spread should be used to compare the heights of high school freshmen and seniors? Explain your reasoning. (See additional stems for the two data sets to compare) Additional Stems for Algebra 1 Found at End of Document.
State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits No Limits.		**Calculator Designation** **YES** – a calculator will be available for items
DOK Ceiling: 3		
Item Format: Selected Response, Constructed Response, Technology Enhanced		

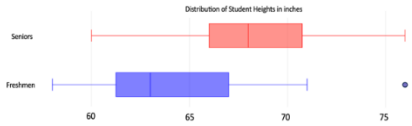
Mathematics		A1.DS.A.3
DS A 3	**Data and Statistical Analysis** **Summarize, represent and interpret data.** Interpret differences in shape, center and spreads in the context of the data sets, accounting for possible effects of outliers.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will interpret differences in shape, center and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

Sample Stems

Use the box plots below to compare (both similarities and differences) the distribution of heights for high school freshmen and seniors. Be sure to include any effect the outlier has on the comparison.



Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 3

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.DS.A.4.a
DS	**Data and Statistical Analysis**	
A	**Summarize, represent and interpret data.**	
4	Summarize data in two-way frequency tables.	
a	Interpret relative frequencies in the context of the data.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.DS.A.4 (a and b) indicate what Algebra 1 students will summarize data in two-way frequency tables.

The student will interpret relative frequencies in the context of the data. For this expectation, joint relative frequency is the combination of two conditions happening together; marginal relative frequency is the total of the two conditions; and conditional relative frequency is the comparison of a specific joint frequency to the corresponding marginal frequency.

Sample Stems

Researchers collected data on the starting salary for 3000 graduates from public colleges and 1000 graduates from private colleges. The results are shown in the table below.

Starting Salary after Graduation vs. Type of College Attended

	Public	Private
Over $100,000	165	160
$50,000 - $100,000	1950	550
Below $50,000	885	290

Based on the data, is a public-school graduate more or less likely than a private-school graduate to have a starting salary over $100,000? Justify your answer.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Sample size (sample population) should be sufficient to interpret the data set, e.g., 40, 60.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.DS.A.4.b
DS	**Data and Statistical Analysis**	
A	**Summarize, represent and interpret data.**	
4	Summarize data in two-way frequency tables.	
b	Recognize possible associations and trends in the data.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.DS.A.4 (a and b) indicate what Algebra 1 students will summarize data in two-way frequency tables.

The student will recognize possible associations and trends in the data. For this expectation, associations include apparent patterns between two variables in data sets, and trends include patterns found in the data set.

Note:
The bigger the differences in the conditional relative frequencies, the stronger the association between the variables. If the conditional relative frequencies are nearly equal for all categories, there may be no association between the variables. Such variables are said to be independent.

Sample Stems

Researchers collected data on the starting salary for 3000 graduates from public colleges and 1000 graduates from private colleges. The results are shown in the table below.

Starting Salary after Graduation vs. Type of College Attended

	Public	Private
Over $100,000	165	160
$50,000 - $100,000	1950	550
Below $50,000	885	290

Based on the data, do starting salaries and the type of college appear to be independent? Justify your answer.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

Sample size (sample population) should be sufficient to interpret the data set, e.g., 40, 60.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.DS.A.5.a
DS	**Data and Statistical Analysis**	
A	**Summarize, represent and interpret data.**	
5	Construct a scatter plot of bivariate quantitative data describing how the variables are related; determine and use a function that models the relationship.	
a	Construct a linear function to model bivariate data represented on a scatter plot that minimizes residuals.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.DS.A.5 (a and b) indicate how Algebra 1 students will construct a scatter plot of bivariate quantitative data describing how the variables are related; determine and use a function that models the relationship.

This includes being given a table of data (or data in context) for two quantitative variables, representing the relationship on a scatter plot and describing how the variables are related. Identify a linear function that best describes the relationship and use this function to solve problems.

The student will create a linear function to fit bivariate data represented on a scatter plot that minimizes residuals (distances from the predicted value).

Sample Stems

Bailey works at a car dealership where she is paid weekly based on the number of cars she sells. The table shows the number of cars she sold and her pay in each of the last 10 weeks.

Week	*Cars sold(x)*	*Pay (y)*
1	6	2500
2	4	1800
3	3	1800
4	5	2300
5	5	2600
6	7	2800
7	2	1000
8	3	1500
9	6	3000
10	4	2200

Create a scatter plot of the data and identify a linear function to represent this data if the function would be used to predict future weeks' data, e.g. minimize residuals.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 3

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.DS.A.5.b
DS	**Data and Statistical Analysis**	
A	**Summarize, represent and interpret data.**	
5	Construct a scatter plot of bivariate quantitative data describing how the variables are related; determine and use a function that models the relationship.	
b	Construct an exponential function to model bivariate data represented on a scatter plot that minimizes residuals.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The expectations in A1.DS.A.5 (a and b) indicate how Algebra 1 students will construct a scatter plot of bivariate quantitative data describing how the variables are related; determine and use a function that models the relationship.

This includes being given a table of data (or data in context) for two quantitative variables, representing the relationship on a scatter plot, and describing how the variables are related. Identify an exponential function that best describes the relationship and use this function to solve problems.

The student will create an exponential function to fit bivariate data represented on a scatter plot that minimizes residuals (distances from the predicted value).

Sample Stems

In 2000, Lincoln High School had 250 seniors. The number of students has been growing exponentially, as shown in the table below.

Year (2000=0)	# of seniors
0	250
1	270
2	300
3	325
4	370
5	410
6	460

Create a scatter plot of the data and identify an exponential function to represent this data if the function would be used to predict future years' data, e.g. minimize residuals.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 3

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.DS.A.6
DS A 6	**Data and Statistical Analysis** **Summarize, represent and interpret data.** Interpret the slope (rate of change) and the y-intercept (constant term) of a linear model in the context of the data.	
Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations. The student will interpret the slope (rate of change) and the y-intercept (constant term) of a linear model in the context of the data.		**Sample Stems** Ms. Lopez believes she can predict how a student will score on the final based on the student's score from the first test, using the equation $y = 10 + 0.9x$ where *x* is the percent score on the first test, and *y* is predicted score on the final. Use Ms. Lopez's model to interpret the meaning of the slope and the y-intercept of the equation in context of this situation. Additional Stems for Algebra 1 Found at End of Document.
State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits No Limits.		**Calculator Designation** **YES** – a calculator will be available for items
DOK Ceiling: 2		
Item Format: Selected Response, Constructed Response, Technology Enhanced		

Mathematics		A1.DS.A.7
DS A 7	**Data and Statistical Analysis** **Summarize, represent and interpret data.** Determine and interpret the correlation coefficient for a linear association.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.

The student will use available technology to determine the correlation coefficient for a linear association.

The student will interpret the correlation (relationship between two variables) and describe the strengths and weaknesses of the correlation coefficient as a measure of linear association.

Sample Stems

Ms. Lopez can predict how a student will score on the final based on their score from the first test, using the equation $y = 10 + 0.9x$ where *x* is the percent score on the first test, and *y* is predicted score on the final. The correlation coefficient is $r = 0.9$

Is Ms. Lopez's equation very good at predicting scores on the final? Justify your answer.

Additional Stems for Algebra 1 Found at End of Document.

State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits

No Limits.

Calculator Designation

YES – a calculator will be available for items

DOK Ceiling: 2

Item Format: Selected Response, Constructed Response, Technology Enhanced

Mathematics		A1.DS.A.8
DS A 8	**Data and Statistical Analysis** **Summarize, represent and interpret data.** Distinguish between correlation and causation.	

Expectation Unwrapped – the intent of this section is to describe the elements of the expectation, but are NOT additional standards or expectations.	**Sample Stems**
The student will distinguish between correlation and causation. The student will understand and explain that a strong correlation does not imply causation.	Use the following statement to distinguish the meaning of correlation and causation. Be sure to include a description of each term's meaning. In elementary school, large shoe sizes correspond to higher reading levels. Additional Stems for Algebra 1 Found at End of Document.
State Assessment Content Limits/Boundaries - Classroom Work Should Extend Beyond These Limits No Limits.	**Calculator Designation** **YES** – a calculator will be available for items
DOK Ceiling: 2	
Item Format: Selected Response, Constructed Response, Technology Enhanced	

<table>
<tr><th>Code</th><th>Sample Stem</th><th>Explanation</th></tr>
<tr><td></td><td>The class is working to extend their understanding of exponents and how having rational exponents are alike and different. Complete the right-hand side of the table below (where the right-hand side has rational exponents).

<table>
<tr><td>$5^3 \cdot 5^2 = 5^{3+2}$</td><td>$(5)^{\frac{1}{3}} \cdot (5)^{\frac{1}{2}} = 5^{?}$</td></tr>
<tr><td>$5^3 \div 5^2 = 5^{3-2}$</td><td>$5^{\frac{1}{3}} \div 5^{\frac{1}{2}} = 5^{?}$</td></tr>
<tr><td>$(5^3)^2 = 5^{3 \cdot 2}$</td><td>$\left(5^{\frac{1}{3}}\right)^3 = ?$</td></tr>
<tr><td>$(5 \cdot 6)^3 = 5^3 \cdot 6^3$</td><td>$(5 \cdot 6)^{\frac{1}{3}} = ?$</td></tr>
<tr><td>$\left(\frac{5}{6}\right)^3 = \frac{5^3}{6^3}$</td><td>$\left(\frac{5}{6}\right)^{\frac{1}{3}} = ?$</td></tr>
</table>

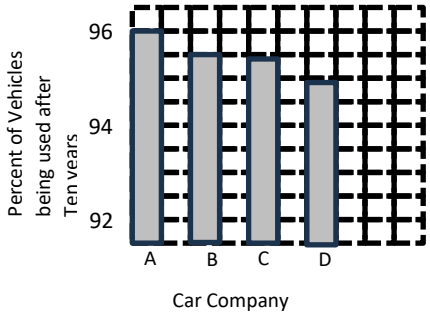
Use the completed table to describe the similarities and differences in integer exponents to rational exponents.</td><td></td></tr>
<tr><td>A1.NQ.A.1</td><td>What value could be used to make the equation below true? Explain your thinking.

$(x)^{\frac{m}{n}} \cdot (\square) = x$</td><td></td></tr>
<tr><td>A1.NQ.A.2</td><td>Patti is looking at exponents and patterns. She begins with the table below looking at the far-left column and sees that each row is changing by multiplying by 2. She notices that the second column is showing the exponential representation when the base is 2.

<table>
<tr><td>$\mathbf{1}$</td><td>$\mathbf{2^0}$</td><td>$\mathbf{4^0}$</td><td>$\mathbf{8^0}$</td></tr>
<tr><td>$\mathbf{2}$</td><td>$\mathbf{2^1}$</td><td>$\mathbf{4}^{?}$</td><td>$\mathbf{8}^{?}$</td></tr>
<tr><td>$\mathbf{4}$</td><td>$\mathbf{2^2}$</td><td>$\mathbf{4^1}$</td><td>$\mathbf{8}^{?}$</td></tr>
<tr><td>8</td><td>2^3</td><td>$\mathbf{4}^{?}$</td><td>$\mathbf{8^1}$</td></tr>
<tr><td>16</td><td>2^4</td><td>$\mathbf{4^2}$</td><td>$\mathbf{8}^{?}$</td></tr>
</table>

What patterns do you see in the 3rd and 4th columns and what exponential values can you use to replace the “?” shown? Explain how the pattern can be represented in the table including the exponent values.</td><td>While the Limits and Boundaries talk about particular rational exponents, students in class should experience additional rational values where appropriate.</td></tr>
</table>

High School Algebra 1

Code	Sample Stem	Explanation
A1.NQ.B.3a	Tim got a new table to put in his room. The table was 4 feet by 3 feet and was 30-inches tall. If his room was a 10-foot by 10-foot room with 8 feet ceilings, how much of the floor space is covered by the new table. Show a labeled sketch of Tim's room and be sure to use the appropriate measurement labels in your work to explain your solutions.	
A1.NQ.B.3b	Which is larger? Explain or show your reasoning. 2 square yards or 24 square feet	
A1.NQ.B.3c	Tim got a new table to put in his room. The table was 4 feet by 3 feet and was 3 feet tall. If his room was a 10-foot by 10-foot room with 8 feet ceilings, how much of the floor space is covered and how much of the room space is taken up by the new table. Be sure to use the appropriate measurement labels in your work to explain your solutions.	
A1.NQ.B.3d	Company A claims that their cars are clearly better since so many more are still on the road after ten years. Interpret the scale, origin, and any other appropriate elements to determine if you agree or disagree with Company A.  Be sure to use values in the graph to support your claim.	
A1.NQ.B.4	Jimmy has a gift box that he wants to wrap to give as a present. Describe what he will need to know to wrap the gift. Be sure to provide the appropriate quantities necessary for this given situation.	
A1.NQ.B.5	Two friends are comparing their heights to that of their math teacher. Describe the type of tool they should use to make these comparisons. Be sure your description includes how accurate the tool is to this "competition".	

High School Algebra 1

Code	Sample Stem	Explanation
A1.SSE.A.1	The class has been given an equation that models the growth of a plant in their classroom. The model being used is $y = 3x + 4$. They measure the number of inches the plant grows every 2 weeks. Given this situation, interpret the contextual meaning of each term in the model.	
A1.SSE.A.2	Given the equation listed below, what are other equivalent forms for this equation? What are the benefits for each equivalent form? $y + 24 = x^2 + 2$	
A1.SSE.A.3a	Given the function listed below, find the zeros by showing the function rewritten in factored form. $f(x) = x^2 + 7x - 8$ What are the zeros in a function?	
A1.SSE.A.3b	Given the function listed below, find the maximum or minimum value of the quadratic function by completing the square. $f(x) = x^2 + 7x - 8$ Be sure to show your work and identify how you know that the coordinate is a maximum or minimum.	
A1.CED.A.1	Tina and Tim are planning to sell ice cream bars at a fair in their town. They plan to sell each bar for $2 and they must pay $25 for space for their booth. If they hope to make at least $200, how many bars must they sell? Create an equation or inequality to model and solve this situation.	
	A family has 30 yards of fencing, and they want to make the largest rectangular space (area) for their pets. Create an equation to model and solve for this situation. Be sure to include how you know this is the largest area.	
A1.CED.A.2	Surf City, Missouri has been growing in population. This year their population is currently 5,200. If Surf City grows annually at a rate of 10 percent, what would be their predicted population in 15 years? Create a model to represent this situation and find the solution.	

High School Algebra 1

Code	Sample Stem	Explanation
A1.CED.A.3	Jimmy's sister is starting a lemonade business. Her expenses can be modeled by the following inequality $y \geq \frac{1}{5}x + 18$ and her earnings are modeled by $y \geq 2x$. Identify the constraints generated by these models and identify data points that would be solutions as well as data points that would not be a solution.	
A1.CED.A.4	Solve the distance formula for r and create a situation where knowing r's value would be of interest.	
A1.REI.A.1	Given the inequality shown below, show each step needed to solve the problem and indicate how the inequality listed in each step is equivalent to the original problem using words, models, or properties. $7 - 3x > 18$	
A1.REI.A.2a	Given the equation listed below, use completing the square to create an equivalent equation. $y = x^2 - 7x - 8$ Show your completing the square using a model or algebraic steps to defend your solution.	
A1.REI.A.2b	Derive the quadratic formula from the following $ax^2 + bx + c = 0$ with a, b, and c being real numbers. Show you thinking using words, symbolic representations, or models.	
A1.REI.A.2c	Of the four methods (graphing, factoring, completing the square, quadratic formula) list a pro (or an ideal situation) and a con (a less ideal situation) to using each method.	Students should be able to recognize that graphing works more effectively if points can be found when you can find the where the quadratic crosses the x-axis (or when it doesn't in case of negative discriminant). They should be able to recognize equations that quickly factor or do not. They should recognize that completing the square works best in particular situations and not others. They should recognize that quadratic formula can have tedious calculations sometimes so other methods could be less "work."
A1.REI.B.3	Given the following system, what would the values of Q and P need to be for each of these situations: An infinite number of solutions, one solution, and no solutions. Explain your choices. y = 3x + 8 and y = Qx + P	The student has to understand the relationship of slope (Q) and y-intercept (P) in each of the solutions. The student would have to understand that in a system under what conditions would the result lead to either infinitely many solutions, one solution, or no solutions.

High School Algebra 1

Code	Sample Stem	Explanation
A1.REI.B.4	Algebraic or graphically, solve the system shown below. $y = x^2 - 2x - 3$ $\quad$ $4x + 2y = 12$	
A1.REI.B.5	Ginny claims that the following two systems are equivalent. Justify how they could both represent the same system. $2x + y = 8$ $\quad$ $4x + 2y = 16$ $-4x + y = 4$ $\quad$ $-4x + y = 4$	
A1.REI.C.6	Graph the following equation and explain the connection between the equation and its graph. $y = 2^x + 3$	
A1.REI.C.7	Graph and describe the solution(s) to the following inequality. $2x - 5y < 15$	
A1.REI.C.8	Jimmy's sister is starting a lemonade business. Her expenses can be modeled by the following inequality $y \geq \frac{1}{5}x + 18$ and her earnings are modeled by $y \geq 2x$. Identify any solution(s) to this system and interpret their meaning given this context.	
A1.APR.A.1	Which operation, + - or x, would create the largest solution for the following expression. $x^2 - 2x - 15 \bigcirc x^2 - 3x - 70$ Explain your answer using mathematical work and reasoning.	Students should place the operation to create largest solution into the circle and explain their thinking and work.
	Simplify the expressions below and collect like terms. Then use these examples to discuss if polynomials are closed under these operations. $(x^3 - 2x^2 - x) - (3x^3 + 4x^2 - x)$ $(2x^3 + x - 1) + (x^3 + x^2 - 4)$ $(x + 4)(2x - 1)$ $(2x^2 + 1)(x^2 - x + 1)$	Classroom discussions should include why division is not included in this list discussing closed operations.

<table>
<tr><th>Code</th><th>Sample Stem</th><th>Explanation</th></tr>
<tr><td>A1.APR.A.2</td><td>Simplify the following and collect like terms:

$\frac{2x^2 - 3x}{x}$

$\frac{16x^2 - 4}{2}$

$\frac{20x^2 + 5x}{5x}$

$\frac{3x^2 + 5x}{x^2}$

Use these expressions to explain why the operations of addition and multiplication are closed for polynomials. Why is division not closed?</td><td></td></tr>
<tr><td rowspan="2">A1.IF.A.1a</td><td>The table below shows four terms in a function.

<table><tr><td>Domain</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Range</td><td>2</td><td>4</td><td>6</td><td>8</td></tr></table>
Write this function in function notation.</td><td></td></tr>
<tr><td>Place 2, 2, 3, 4, 5, 5, 8, 11 in the table below to create the situation described:

A relation that is a function
<table><tr><td>Domain</td><td></td><td></td><td></td><td></td></tr><tr><td>Range</td><td></td><td></td><td></td><td></td></tr></table>
Write this function in function notation.</td><td>For students who are struggling to differentiate between relations that are functions and those that are not, an extension could be to have students use the same set of numbers to show a relation that is not a function.</td></tr>
<tr><td rowspan="2">A1.IF.A.1b</td><td>How can you use the graph of the following equation to verify that it is indeed a function?

$f(x) = 7x + 2$

Support your explanation including how domain, range, and ordered pairs that satisfy the equation.</td><td></td></tr>
<tr><td>If $f(x)$ and $g(x)$ are two linear functions such that $f(2) = g(2)$ describe something you know about both these two functions.</td><td></td></tr>
<tr><td>A1.IF.A.2</td><td>A function $C(m)$ gives the number of canceled school days, C, for any given month, m. What does $C(1) = 6$ mean in the context of this situation?</td><td></td></tr>
</table>

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<table>
<tr><th>Code</th><th>Sample Stem</th><th>Explanation</th></tr>
<tr><td rowspan="2">A1.IF.B.3</td><td>Audrey and Aaron have summer jobs stuffing envelopes for two different companies. Audrey earns $12 for every 400 envelopes she finishes. Aaron earns $6 for every 300 envelopes he finishes.

Describe the key characteristics for each function that would model these two relationships. How would these characteristics help to compare each person's earnings after stuffing the same number of envelopes?</td><td></td></tr>
<tr><td>The relationship between a day's temperature, in degrees Fahrenheit, for each hour after noon is shown in the table:

<table><tr><td>Hrs past noon</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td>Temp</td><td>71</td><td>74</td><td>79</td><td>86</td><td>95</td><td>86</td><td>79</td><td>74</td><td>71</td><td>70</td></tr></table>
Write a description of the day's temperature over time describing key characteristics, including details such as when the day was becoming hotter and colder, when the temperature was the hottest, and others as needed.</td><td></td></tr>
<tr><td>A1.IF.B.4</td><td>Baxter deposits $500 into a savings account that earns 2% interest each year. The function below represents how much money A is in Baxter's account t years after the savings account is opened.

$$A = 500(1.02)^t$$

Graph this function and use the graph to describe the domain and range of the function and how the graph supports your description.</td><td></td></tr>
<tr><td>A1.IF.B.5</td><td>The table shows a company's value over several years after being founded:

<table><tr><td>Time in years</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Value (in thousands of dollars)</td><td>10</td><td>15</td><td>17</td><td>8</td><td>-20</td></tr></table>
Describe the company's performance between years 1 and 5, including the average rate of change and a description of what that means in this context.</td><td>One extension could be to have students compare each interval to the average rate of change.</td></tr>
</table>

	The table shows a company's value over several years after being founded: Time in years: 1, 2, 3, 4, 5 Value (in thousands of dollars): 10, 15, 17, 8, Fill in the missing value in the table creating two different situations. First, identify a value that would yield a positive average rate of change over the first five years of the company and determine that rate of change. Next, identify a value that would yield a negative average rate of change over the first five years of the company, and determine that rate of change.	
Code	Sample Stem	Explanation
A1.IF.B.6	Using the function A = 300(0.96)^t, identify a situation or context the function represents. Explain what happens to the value of the function as the values for t increase. Be sure to indicate the meaning of the relevant parts of the function.	
A1.IF.C.7	Sutton used her graphing utility to compare each of the graphs below to the graph of using several values for a, h, and k. She noticed some patterns in the changing of the graph. What patterns might have Sutton seen? Be sure to include in your discussion how the graph changes including shifts and the direction of the shift, as well as stretches. Be specific to the affect a, h and k have on the graph and include some of the values you used in your exploration. A. y = ax^2 B. y = (x+h)^2 C. y = x^2+k	
A1.IF.C.8	Thomas and Shawna are graphing the quadratic function $y = 2x^2 - 4x - 6$ Thomas claims the function is easier to graph in the form $y = 2(x - 3)(x + 1)$ Shawna disagrees and claims that she would rather graph it in the form $y = 2(x - 1)^2 - 8$ For each student explain how their form might be easier to graph. Be sure to include a description of the key features to defend each position.	

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<table>
<tr><th>Code</th><th>Sample Stem</th><th>Explanation</th></tr>
<tr><td>A1.IF.C.9</td><td>At a high school baseball game, a throwing contest is held. The path of Sam's throw is given by the equation $y = -16t^2 + 70t + 7$

Where y represents the height of the ball t seconds after it is thrown.

Jessica's throw is given in the table below:

<table>
<tr><td>Time after throwing in seconds</td><td>0</td><td>.5</td><td>1</td><td>1.5</td><td>2</td><td>2.5</td></tr>
<tr><td>Height of ball above ground in feet</td><td>5.5</td><td>37.5</td><td>61.5</td><td>77.5</td><td>85.5</td><td>85.5</td></tr>
</table>

Who would win the contest if the goal was to be highest, longest, or farthest? What key characteristics of the functions help determine the winner for each of these situations?</td><td></td></tr>
<tr><td>A1.BF.A.1</td><td>Graph and use the following function to describe the effects of each of the transformations listed below.
$f(x) = x^2 - 4$

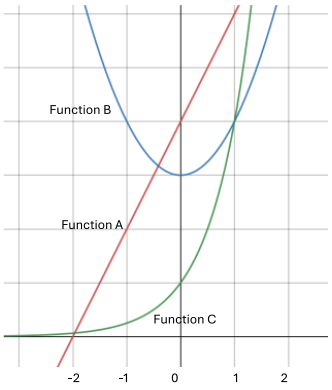
Transformations to use in your description:
$3f(x)$ $f(x) + 4$ $f(x + 4)$ $3f(x + 4)$</td><td></td></tr>
<tr><td rowspan="3">A1.LQE.A.1a</td><td>The income on Sutton's lemonade stand can be modeled by the function f(x) = 4x - 1.5, where x represents the number of lemonades sold. What is the difference in income on the lemonades sold from r lemonades sold to r + k lemonades sold?</td><td></td></tr>
<tr><td>Let f(x) = ax + b. If one x coordinate can be represented by q and another by q + m, what would be the difference in heights of the y values?</td><td></td></tr>
<tr><td>The population of Jefferson City, MO in 2021 was 42,772. What could the population have been in 2022, 2023, and 2024 if the population grew at a linear rate?</td><td></td></tr>
</table>

<table>
<tr><th>Code</th><th>Sample Stem</th><th>Explanation</th></tr>
<tr><td></td><td>The population of Jefferson City, MO in 2021 was 42,772. What could the population have been in 2022, 2023, and 2024 if the population grew at an exponential rate?</td><td></td></tr>
<tr><td>A1.LQE.A.1b</td><td>Freddie the farmer's barn was being overrun with mice. He went out and got a cat that was very good at catching mice. On the day Freddie brought the cat home, he estimated that his barn had 1000 mice.

Use the information from the table below to describe the type of function represented by bringing the cat to the barn. Include specific information on how the estimated mouse population is changing to support your description.

<table><tr><td>Weeks after getting a barn cat</td><td>1</td><td>2</td><td>3</td></tr><tr><td>Estimated number of Mice in the barn</td><td>900</td><td>810</td><td>729</td></tr></table></td><td></td></tr>
<tr><td>A1.LQE.A.2</td><td>A group of students are comparing three different functions (Function A, Function B, and Function C).

Alina looks at the following graph of the three functions and determines that, because function A shows the greatest value after an input of approximately -0.5, function C will never be greater than function A. Do you agree or disagree? Why?

Pablo decides to compare the three functions using their tables:</td><td></td></tr>
</table>

Function A:

x	-1	-0.5	0	0.5	1
y	2	3	4	5	6

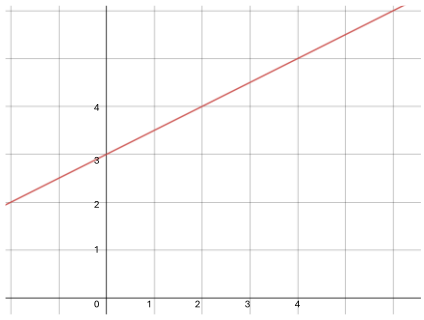
Function B:

x	-1	-0.5	0	0.5	1
y	4	3.25	3	3.25	4

Function C:

x	-1	-0.5	0	0.5	1
y	0.25	0.5	1	2	4

Pablo states that, because function C did not increase as much as function A in the tables he created, function C will never be greater than function A. Do you agree or disagree? Why?

Code	Sample Stem	Explanation
A1.LQE.A.3	Penicillin, a medication that eliminates bacteria, is introduced to a culture of 20,000 bacteria. The penicillin eliminates 65% of the bacteria each hour. Write a function to model the number of bacteria remaining each hour after the penicillin is administered.	
	Construct a function for the following graph: 	
	Construct a function from the table shown:	

x	-4	-3	-2	-1	0	1	2	3
y	0	-5	-8	-9	-8	-5	0	7

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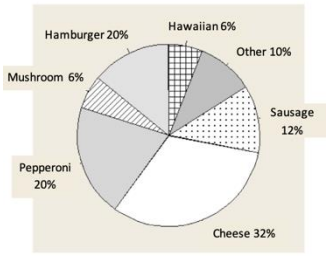
Code	Sample Stem	Explanation
A1.LQE.B.4	A popular game show gives its winner a choice of two prizes: The first option is that the winner can receive $1000 tomorrow, and then receive $500 per day for a month. The second option is that the winner can receive $2 tomorrow, $4 the day after, and continue to double the prize money each day for a month. Which prize option should the winner select? Write a sequence that models each prize choice and use these to support your conclusion.	Teachers should have ready both a recursive and an explicit form to share (as examples from other classes) during the discussion of solutions. Students should be encouraged to use both forms and having these during the concluding discussions could be useful if both forms were not ones used.
A1.LQE.B.5	Compare (describe both the similarities and differences) the following sequences: $f(n) = 2n + 1$ $a_{n+1} = a_{n-1} + a_n$, where $a_1 = 1$ and $a_2 = 3$	
A1.LQE.B.6	Write the first 6 terms of the sequence: $a_{n+1} = a_{n-1} + a_n$, where $a_1 = 1$ and $a_2 = 3$	
A1.DS.A.1	The pie chart below describes the distribution of favorite pizzas for 300 high school freshmen. Analyze the claims below to determine their accuracy in describing information contained in this chart.  • Taken together, more than half the students preferred pepperoni, hamburger, or sausage. • Fewer than 10 students prefer mushroom pizza. • Twelve students prefer either mushroom or Hawaiian pizza. • No students like veggie pizzas. • More than 50 students prefer cheese pizza.	

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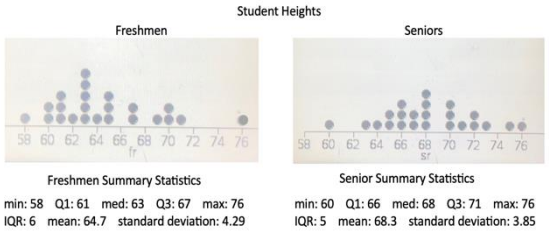
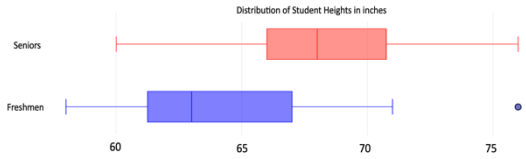
<table>
<tr><th>Code</th><th>Sample Stem</th><th>Explanation</th></tr>
<tr><td>A1.DS.A.2</td><td>Based on the dot plots and summary statistics given below, which measures of center and spread should be used to compare the heights of high school freshmen and seniors? Explain your reasoning.
 

Freshmen Summary Statistics
min: 58 Q1: 61 med: 63 Q3: 67 max: 76
IQR: 6 mean: 64.7 standard deviation: 4.29
Senior Summary Statistics
min: 60 Q1: 66 med: 68 Q3: 71 max: 76
IQR: 5 mean: 68.3 standard deviation: 3.85</td><td></td></tr>
<tr><td>A1.DS.A.3</td><td>Use the box plots below to compare (both similarities and differences) the distribution of heights for high school freshmen and seniors. Be sure to include any affect the outlier has to the comparison.
 
</td><td></td></tr>
<tr><td>A1.DS.A.4a</td><td>Researchers collected data on the starting salary for 3000 graduates from public colleges and 1000 graduates from private colleges. The results are shown in the table below.

Starting Salary after Graduation vs. Type of College Attended
<table><tr><th></th><th>Public</th><th>Private</th></tr><tr><td>Over $100,000</td><td>165</td><td>160</td></tr><tr><td>$50,000 - $100,000</td><td>1950</td><td>550</td></tr><tr><td>Below $50,000</td><td>885</td><td>290</td></tr></table>
Based on the data, is a public-school graduate more or less likely than a private-school graduate to have a starting salary over $100,000? Justify your answer.</td><td></td></tr>
</table>

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<table>
<tr><th>Code</th><th>Sample Stem</th><th>Explanation</th></tr>
<tr><td>A1.DS.A.4b</td><td>Researchers collected data on the starting salary for 3000 graduates from public colleges and 1000 graduates from private colleges. The results are shown in the table below.

Starting Salary after Graduation vs. Type of College Attended
<table><tr><th></th><th>Public</th><th>Private</th></tr><tr><td>Over $100,000</td><td>165</td><td>160</td></tr><tr><td>$50,000 - $100,000</td><td>1950</td><td>550</td></tr><tr><td>Below $50,000</td><td>885</td><td>290</td></tr></table>
Based on the data, do starting salaries and the type of college appear to be independent? Justify your answer.</td><td></td></tr>
<tr><td>A1.DS.A.5a</td><td>Bailey works at a car dealership where she is paid weekly based on the number of cars she sells. The table shows the number of cars she sold and her pay in each of the last 10 weeks.
<table><tr><th>Week</th><th>Cars sold(x)</th><th>Pay (y)</th><th>Week</th><th>Cars sold</th><th>Pay</th></tr><tr><td>1</td><td>6</td><td>2500</td><td>6</td><td>7</td><td>2800</td></tr><tr><td>2</td><td>4</td><td>1800</td><td>7</td><td>2</td><td>1000</td></tr><tr><td>3</td><td>3</td><td>1800</td><td>8</td><td>3</td><td>1500</td></tr><tr><td>4</td><td>5</td><td>2300</td><td>9</td><td>6</td><td>3000</td></tr><tr><td>5</td><td>5</td><td>2600</td><td>10</td><td>4</td><td>2200</td></tr></table>
Create a scatter plot of the data and identify a linear function to represent this data if the function would be used to predict future weeks' data, e.g. minimize residuals.</td><td></td></tr>
<tr><td>A1.DS.A.5b</td><td>In 2000, Lincoln High School had 250 seniors. The number of students has been growing exponentially, as shown in the table to the right.
<table><tr><th>Year (2000=0)</th><th># of seniors</th></tr><tr><td>0</td><td>250</td></tr><tr><td>1</td><td>270</td></tr><tr><td>2</td><td>300</td></tr><tr><td>3</td><td>325</td></tr><tr><td>4</td><td>370</td></tr><tr><td>5</td><td>410</td></tr><tr><td>6</td><td>460</td></tr></table>
Create a scatter plot of the data and identify an exponential function to represent this data if the function would be used to predict future years' data, e.g. minimize residuals.</td><td></td></tr>
<tr><td>A1.DS.A.6</td><td>Ms. Lopez believes she can predict how a student will score on the final based on the student's score from the first test, using the equation $y=10+0.9x$ where x is the percent score on the first test, and y is predicted score on the final.

Use Ms. Lopez's model to interpret the meaning of the slope and the y-intercept of the equation in context of this situation.</td><td></td></tr>
</table>

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Code	Sample Stem	Explanation
A1.DS.A.7	Ms. Lopez can predict how a student will score on the final based on their score from the first test, using the equation y =10+0.9x where x is the percent score on the first test, and y is predicted score on the final. The correlation coefficient is $r = 0.9$ Is Ms. Lopez's equation very good at predicting scores on the final? Justify your answer.	
A1.DS.A.8	Use the following statement to distinguish the meaning of correlation and causation. Be sure to include a description of each term's meaning. In an elementary school, large shoe sizes correspond to higher reading levels.	
	In Ms. Lopez's algebra class, Lisa asked James if he wanted to join her study group for the final. James said that he didn't need to study – he was going to stop playing video games for the week and that would make his grade on the final go up. Do you agree with James? Explain your reason.	